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ABSTRACT

This paper reports on the results of several experiments concerned with instructions to forget certain information and to remember other information presented in the context of a variety of laboratory tasks of short-term memory. Assessment of the retention of remember material indicated that it varies directly with the degree to which clear cognitive differentiation of forget and remember material is permitted and the extent to which one is able to devote all rehearsal activity to remember material. These mechanisms of differential grouping and differential rehearsal were also implicated by the observation that information one is directed to forget is not expunged from memory but is still largely available in storage. The effects of these two processes permit the later operation of a third directed forgetting mechanism, selective search (focusing at retrieval time on the to-be-remembered information). The results of various studies of non-intentional forgetting are also reported. The significant conclusions which they suggest include: tip-of-the-tongue states are relatively transient, the temporal dating of to-be-remembered events may not be important to their retrieval, and selective rehearsal may be at the root of a number of situations in which short-term memory is facilitated. (Author/WR)

Final Report

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SELECTIVE AND INTENTIONAL FORGETTING

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U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
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Author's Abstract

Instructions to forget certain information and to remember other information were presented in the context of a variety of laboratory tasks of short-term memory. Assessment of the retention of remember material indicated that it varies directly with the degree to which clear cognitive differentiation of forget and remember material is permitted and the extent to which one is able to devote all rehearsal activity to remember material. These mechanisms of differential grouping and differential rehearsal were also implicated by the observation that information one is directed to forget is not expunged from memory but is still largely available in storage. The effects of these two processes permit the later operation of a third directed forgetting mechanism, selective search (focusing at retrieval time on the to-be-remembered information).

The results of various studies of nonintentional forgetting are also reported. The significant conclusions which they suggest are to be the following: (1) tip-of-the-tongue states are relatively transient; (2) the temporal dating of to-be-remembered events may not be important to their retrieval; (3) selective rehearsal may be at the root of a number of situations in which short-term memory is facilitated, e.g., where to-be-remembered events are perceptually isolated.

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Preface

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GENERAL INTRODUCTION

The general concern of this grant has been with problems of human memory. The approach to these problems has sometimes involved simple laboratory tasks in which rather than instructing a subject to remember material, he is instead directed to forget information intentionally. The underlying belief has been that such an emphasis may yield insights into the human memory system which would not otherwise have been forthcoming through more traditional procedures. In addition, forgetting is such a pervasive phenomenon as to suggest that it has useful or adaptive characteristics. Thus questions concerning how one forgets information voluntarily or intentionally were of especial interest in this research. The description of our investigations begins with those studies which have used a directed forgetting procedure. Then follows a second major division covering studies of nonintentional forgetting.

INTRODUCTION TO STUDIES OF INTENTIONAL FORGETTING

A Procedure and Previous Results

The methods and results of experiments in which subjects are instructed to forget information deliberately have been reviewed in monographs by Bjork (1972) and Epstein (1972) and the interested reader is directed to these sources for a complete introduction to the topic. For present purposes, it will suffice to give an example of an intentional forgetting procedure and to mention the sorts of observations commonly made. A very simple situation which we have used involves presenting lists of words sequentially after each of which the subject is tested by the method of free recall, that is, he is asked to recall as many of the words as possible in any order he wishes. To turn this into an intentional forgetting task, we can inform the subject that during some of the lists but not all of them, a signal (e.g., a buzzer) will occur after one of the list members. The subject is further instructed that this means to forget all items prior to the buzzer (the forget words) and to remember only those subsequent to the buzzer (the remember words). He is not told, however, as to whether the particular list about to be presented will contain a forget cue.

Concerning the results of this kind of procedure, arranging things such that lists with and without cues include the same number of remember words permits a simple comparison between the mean number of such items retrieved from forget-cue and non-forget-cue lists. This gives an idea of the extent to which forget words interfere with the recall of remember words. Very often the interference is negligible indicating positive or functional forgetting of forget material. However that such material is still available in storage and is not forgotten is clearly revealed by direct tests of forget items. The problems inherent in this approach are perhaps obvious; but in the context of our illustrative procedure, they can be circumvented in part by administering such a test after a final forget-cue list of a laboratory session, that is, when contradicting the rules of the task can no longer matter. By way of a general summary statement concerning the results of intentional forgetting studies, it would appear that forget items, while still largely available in storage, need not have any substantial interference effect on the retrieval of remember items.

Mechanisms of Intentional Forgetting

We shall mention five mechanisms of intentional forgetting which have been proposed. One is an erasure process. By this is meant that the human memory system possesses the capacity to expunge information from memory upon command.

A second mechanism applies to situations in which what are forget materials for one group of subjects must be maintained in mind by a comparison group while remember materials are being tested. The idea here is that we have a limited capacity retrieval mechanism and that the presentation of a forget cue releases this mechanism for attention to only those items which must be remembered thereby facilitating performance. This has also been referred to as a recycling hypothesis by Epstein (1969). By this is meant that a forget instruction can improve test performance because it liberates one from having to recycle forget items for later retrieval while one is searching for remember items.

Three other mechanisms may be discussed simultaneously, inasmuch as they do not appear to be mutually exclusive of one another. These three mechanisms are differential grouping, differential rehearsal, and selective search. The differential grouping notion is a storage process and means that forget and remember material are tagged differentially or grouped in storage such that any interference between the two kinds of items is substantially reduced. Differential rehearsal is the notion that upon the occurrence of a forget instruction all rehearsal energies are oriented toward remember information and away from forget information. The idea of selective search is an emphasis on the importance of retrieval processes. The argument is that a forget signal may permit a subject to restrict his search to a smaller well-demarcated set of items thereby improving performance. The interrelatedness of these mechanisms can be readily appreciated. For instance, in order for differential rehearsal to occur, the forget and remember sets must be differentiated in mind. Differential rehearsal, in turn, would appear to be conducive to establishing sets of items upon which a selective search process can operate. Finally, selective search seems to presuppose the existence of sets of items which have been differentiated in memory. Speaking more generally, the occurrence of any one of these processes seems to imply the operation of at least one of the remaining ones.

We turn now to a description of our experiments on directed forgetting. While the research bears mainly on the notions of differential rehearsal and differential grouping, it has implications for all five of the mechanisms just mentioned and these will be pointed out as each experiment is presented.

EXPERIMENTS ON INTENTIONAL FORGETTING

Experiment 1

The main concern of this experiment was with the directed forgetting mechanism of differential grouping. It has been shown that the interference effects of an initially presented set of items on the recall of a second set of items can be largely diminished if one is instructed to forget the first set of items (e.g., Bjork, 1970). The question raised in this experiment was how effective a forget cue would be when the discriminability between the two sets of items was reduced. To effect such a reduction two variations were tried. One was to make the remember and forget items categorically similar; the other was to institute a delay prior to recall.

Method. The general procedure of this experiment was the alternate presentation and test by the method of free recall of different lists of words. In some of the lists, but not all of them, a forget cue (a dollar sign for half the subjects and three asterisks for the other half) was interpolated between two of the words. This meant that the subject was not responsible for recalling any of the words which preceded the cue, only those which followed it. And, of course, he did not know in advance whether or not a list would contain such a signal.

Each of 128 college students saw eight lists of words presented at a 2.5-second rate. These eight lists represented the factorial combination of three independent variables. One such variable was the nature of the list members, either common unrelated words or categorically related words chosen from the Cohen, Bousfield and Whitmarsh (1957) norms. As a second variable, the written free recall tests after each list were administered either immediately or after a 2-minute interval of solving number-series or arithmetic problems.

The final independent variable was the presence or absence of a forget cue. For lists of unrelated words, there were 15 remember items and 15 forget items which antedated any cue. The comparable figures for lists of categorical words were 25 and 25. For the latter type of material, the remember items were five exemplars from each of five categories. And they were blocked in the presentation sequence. Any forget

items in a list were five different exemplars selected from each of the same five categories and also presented in block fashion. Thus, a categorical forget cue list contained forget and remember words which were drawn from the same conceptual classes. The presentation order of the lists insured that materials and conditions were counterbalanced.

Over and above the lists described to this point, there was also a final list which consisted of 30 unrelated words with a forget cue after the 15th item. Half the subjects were tested under a "forget" condition. They were left to believe in what a forget cue had always meant up to this juncture. However, at the end of the list and contrary to the original instructions, these subjects were asked to recall only those words which had been presented prior to the forget cue. The other half of the subjects were tested under a "divide" condition. Before the last list, members of this group were told that a forget cue would occur but that now they should treat the cue as a point of division of the list into two parts, and that they should try to remember each part as if it were a separate list. They were also informed that they would be tested on both parts although they did not know in which order. Like the forget group, of course, they were subsequently asked to recall the first segment first. Following recall of this set of items, both groups were then asked to write down as many of the post-cue items as they could.

Results and Discussion. Table 1 shows means and standard deviations for recall of the remember words for the first eight lists. It is clear that the mean number of unrelated words recalled whether immediately or after a delay was independent of the occurrence of a forget signal, F (1, 120) < 1. By contrast, recollection of categorical items for lists containing a forget instruction was depressed with an apparently greater effect when recall was immediate rather than delayed, F (1, 120) = 54.24 and 8.87, $p < .001$ and .01, respectively.

There are at least two problems in drawing definitive conclusions from these data. First, if one considers the recall of unrelated words, it cannot be said that the forget cue eliminated interference owing to forget items. Rather it could be simply that recall from no-forget-cue lists was depressed because of the uncertainty as to what was going to be tested under such conditions. The point can perhaps be

Table 1

Recall of the Eight Lists of Unrelated and Categorical Words

Test	Forget Cue	Unrelated words		Categorical words	
		Mean	SD	Mean	SD
Immediate	Absent	7.1	2.5	15.8	4.1
	Present	6.9	2.5	13.4	3.7
Delayed	Absent	5.1	2.7	12.8	4.7
	Present	5.2	2.6	11.9	3.7

appreciated by consideration of forget-cue conditions where upon the occurrence of the cue, the subject knows for certain he is going to be responsible for recalling each item he sees thereafter. Of course, precisely the same problem exists with respect to categorical materials. A second point is that even though there was interference in the recall of categorical lists when forget items were presented, it could still be the case that the forget cues have led to some diminution of such interference. But to know this for certain would require a condition in which two sets of items are presented without the subject knowing until the end of the list that it is the second set he is to recall. Experiment 2 was designed to cope with these two difficulties.

Data concerning recall of the pre- and post-cue segments of the final list appear in Table 2. Recall of the segment prior to the signal was reliably lower when the cue was a forget instruction, F (1, 126) = 6.00, $p < .05$; the compensatory difference in favor of the forget condition on the second test, however, was not statistically significant, F (1, 126) = 3.49, $p > .05$.

Table 2

Recall of the Final List

List segment	Cue meaning	Mean	SD
Pre-cue (test 1)	Forget	3.1	2.7
	Divide	4.2	2.6
Post-cue (test 2)	Forget	3.8	3.0
	Divide	2.8	2.4

These data accord well with the notion of differential rehearsal. Upon the occurrence of the cue, the assumption is that the divide group would attempt to keep both segments in mind whereas the forget group would rehearse only the second segment, dropping the first from mind. The obtained pattern of results follows from this analysis. On the other hand, the recycling mechanism discussed earlier does not seem to be a very potent factor. In other words, the divide group, even though it had to keep the post-cue segment "alive" while recalling the pre-cue segment, still did better on test 1 than did the forget group which was not explicitly instructed that it would have to recall the post-cue segment. In addition, perfect operation of an erasure mechanism is soundly denied by the evidence that forget words can be recalled. The conclusion, then, is that a forget instruction leads to a shift toward rehearsal of to-be-remembered items and away from rehearsal of those which can be forgotten. That such differential rehearsal need not affect overall performance is clear from the fact that the divide and forget groups produced virtually the same number of items from the list considered as a whole. In short, given a fixed amount of study time, a constant amount can be recalled (cf. Reitman, Malin, Bjork, & Higman, 1973; Epstein, 1969).

Experiment 2

Method. The main difference between Experiment 1 and the present one, was that rather than simply forget or non-forget-cue lists, there were five different conditions. Control lists C1 and C2 contained only one set of words. Under the C1 condition, however, the initial visual label "Set 1" was presented thus leaving open the possibility that a second set might be presented (it never was). Under the C2 condition, the initial label was "Set 2" thereby indicating that the set to follow would be the only one to be presented. Three other conditions involved forgetting the first set of words (F2), probing for the first set (P1), and probing for the second set (P2). Under F2, the first set of items was cued after its presentation to be forgotten and thus the subject knew that set 2 would be tested. Under P1 and P2, the instruction after the first set was to retain it with the final instruction being to recall set 1 and set 2, respectively.

Of the probe conditions, P1 was included to authenticate the instructions that either the first or the second set would be tested. However, its data are of no particular interest for present purposes, and will not be described. The remaining conditions, C1, C2, F2, and P2, can be conceived of as representing the orthogonal combination of two two-level factors. One was an uncertainty variable. In the C2 and F2 conditions, subjects knew before the end of a list which items would be tested but they did not in the C1 and P2 conditions. The other variable was the presence of interference items prior to the remember set. There were no such items in the C1 and C2 conditions but there were in the F2 and P2 conditions.

The other main differences from the prior experiment were that there was no final list of the kind presented in Experiment 1, the time-of-testing variable was a between-subjects factor, and there were 80 subjects tested.

Results and Discussion. Immediate and delayed recall of unrelated and categorical remember words under the critical conditions C2, C1, F2, and P2 are described in Table 3. Considering first recall of unrelated words, it is clear that in general prior knowledge of which items are to be tested improved recall, $F\ (1, 60) = 23.34$, $p < .001$, while the presentation of forget items prior to the set of remember

Table 3

Recall of Unrelated and Categorical Remember Words

Test	Condition	Unrelated Words		Categorical Words	
		Mean	SD	Mean	SD
Immediate	C2	6.7	2.5	15.6	3.5
	C1	5.9	2.3	14.3	4.0
	F2	6.7	2.2	13.2	3.9
	P2	5.2	2.1	12.2	3.5
Delayed	C2	5.2	2.9	11.5	3.6
	C1	4.4	2.1	12.4	4.7
	F2	4.2	2.3	10.8	3.3
	P2	2.7	2.3	9.1	3.2

items diminished performance, F (1, 60) = 19.91, $p < .001$. However, the interaction of time of testing and the presence of prior items, F (1, 60) = 6.43, $p < .05$, makes it clear that most of the proactive interference occurred under delayed testing. If one takes 1-((C2-F2)/(C1-P2)) as a measure of the amount of interference overcome by a forget instruction, then it would appear that a forget cue under immediate testing was 100% effective in eliminating interference from prior forget items, whereas in the delayed condition it was approximately only 40% effective.

With categorical words, the debilitating influence of prior items was evident under both immediate and delayed testing, F (1, 60) = 43.67, $p < .001$. The effect of prior knowledge of which items were to be tested was somewhat irregular; with delayed testing, performance under the C1 condition was actually better than performance under the C2 condition. This reversal was reflected in a statistically significant interaction of the three factors of this experiment, F

(1, 60) = 4.46, $p < .05$. As to the question of how effective a forget cue was in overcoming the interference owing to forget items, use of the formula described above indicates that it was totally ineffective in immediate testing but roughly 80% effective under delayed testing.

Based on this experiment then, we may conclude that with unrelated words and immediate testing, a forget cue administered immediately after the presentation of a set of words can neutralize the interference owing to these items. With delayed testing of unrelated words or immediate or delayed testing of categorical words, such cuing is not nearly so potent. Indeed, with categorical words tested immediately after their presentation, a forget cue was totally ineffective in the reduction of forget-word interference. These observations lend considerable support to the importance of the mental differentiation of sets of remember and forget words; making their differentiation more difficult can result in the absence of any evidence of positive forgetting.

Experiment 3

If set differentiation is a necessary condition for positive forgetting, then one should be able to observe evidence of difficulties in actually discriminating between forget and remember items, particularly where our recall tests have shown interference effects owing to forget items. Accordingly, the objective of Experiment 3 was to observe the accuracy of discrimination under conditions like those of Experiments 1 and 2.

Method. Unlike the free-recall procedure of the previous two experiments, Experiment 3 used a "Yes-No" recognition test. For this purpose, remember and forget words were scrambled together and laid out in a column on a test sheet. In the case of a list which had contained a forget cue (a dollar sign in this study), the subject was asked to circle the remember words but not the forget words. For lists which did not contain a forget cue, that is, consisted only of remember words, the subject was asked to circle only those words which had been presented to him and not those which had not.

As in Experiments 1 and 2, half the lists consisted of unrelated words and half of categorical words. Lists of unrelated words contained 15 remember

items and if a forget signal occurred, 15 forget items. The comparable figures for the categorical lists were again 25 and 25. Testing was either immediate or delayed for a period of 2 min. The latter variable was a between-subjects factor; the materials and forget-cue variations were within-subjects factors. Thus, each subject saw four lists, either categorical or unrelated and with or without a forget instruction. Once again, list presentation orders observed a counterbalancing of materials and conditions. Presentation was visual at a 2.5 second rate. There were 58 subjects in this experiment, 29 in each of the immediate and delayed testing conditions.

Results and Discussion. Table 4 summarizes discrimination performance as indexed by the Yes-No recognition procedure. Hits and false alarms refer respec-

Table 4

Mean Numbers of Hits (H) and False Alarms (FA) for Unrelated and Categorical Words

Test	Forget Cue	Unrelated Words		Categorical Words	
		H	FA	H	FA
Immediate	Absent	11.1	.3	21.4	1.1
	Present	8.7	3.2	18.8	5.2
Delayed	Absent	10.2	1.3	20.3	2.9
	Present	7.6	3.5	17.1	6.2

tively to items circled which were and were not remember words. It is quite clear that discrimination performance was uniformly superior for lists which did not contain a forget instruction. In all instances forget cue conditions on the average resulted in fewer hits and more false alarms than the appropriate comparison conditions, F (1, 56) $\geq$ 33.32, $p < .001$ in all cases. Thus, it would appear that experimental arrangements in which forget items can interfere with the recall of remember items can also produce difficulties in discriminating between forget and remember words. That such impaired

discrimination is a necessary although not a sufficient condition for interference from forget items is indicated by the fact that whereas discrimination difficulties were observed in the recognition of unrelated words under immediate testing, such conditions in Experiments 1 and 2 produced no evidence of forget-word interference.

Experiment 4

This experiment was further concerned with the influence of forget words on the recollection of remember words. Up to this point we have observed that with immediate testing of unrelated words, the administration of a forget cue can in some way overcome interference owing to forget items. The question asked in this experiment was whether turning the forget items into a somewhat more active storage load would produce debilitating effects on recall. By this we meant getting our subjects to expend some effort to keep the forget material "alive" in memory.

Method. Each of 134 subjects saw 10 lists of unrelated common words presented at a 2.5 second rate. Five of the lists contained forget cues and five did not with no more than two consecutive occurrences of either kind of list. The number of items prior to a forget instruction varied. There were either 4, 6, 8, 10, or 12 forget words with each value being used once. After a forget signal and in lists without such a signal, there occurred 12 remember words and these were tested by the method of free recall.

The nature of the memory load due to the forget items was varied in the following manner. For half the subjects, the signal to forget conveyed the same meaning that it did in the experiments which have already been described. The cue for this purpose was the words "Now forget" against a background of slanting lines. Since these items could be dismissed from any further active consideration, they were deemed to represent a passive storage load. The comparable instruction for the remaining half of the subjects was the words "Test later" again displayed against a background of slanting lines. This meant that the subject was to try to keep the forget items in mind, because while they would not be tested at the end of the list in which they occurred, they would be tested at the end of the experiment. Because of the responsibility for having to keep the forget items alive, they were judged to represent an active storage load.

At the conclusion of the experiment, two tests were given to all subjects. First, there was a free-recall test of all forget words. After 3 minutes of working at this, a 40-item, 4-alternative, forced-choice recognition test of the forget items was administered.

Results and Discussion. Table 5 presents means and, in parentheses, standard deviations for performance on immediate and final retention tests. Our

Table 5

Means and Standard Deviations (in Parentheses) for Immediate and Final Retention Tests

Nature of Instruction	Cue	Immediate Test	Final Test	
		Correct Recall	Recall	Recognition
Forget	Absent	6.4 (1.2)	—	—
	Present	6.4 (1.3)	2.6 (2.3)	26.3 (6.0)
Test later	Absent	6.5 (1.3)	—	—
	Present	5.9 (1.6)	4.4 (3.3)	26.5 (6.8)

initial analysis indicated that the effect of the number of forget words in the list - 4, 6, 8, 10, or 12 - was neither systematic nor consistent. Accordingly, the five cue lists were considered as one as were the five no-cue lists thus yielding two mean recall scores for each subject. What is shown in the immediate test column of Table 5 are means and standard deviations of these means for the four main conditions of the experiment. The immediate recall data indicated an interaction between the nature of the forget instruction and whether or not any instruction occurred, $F(1, 132) = 11.71$, $p < .001$. That is, only in the test-later condition, where presumably the forget items

served as an active memory load, was there an adverse influence on the immediate recall of remember items. The difference in performance between conditions in which a forget cue and a test-later cue was present was on the order of half an item and was statistically reliable, F (1, 132) = 16.42, $p < .001$.

The interpretation of the immediate recall data preferred here is that the active storage load of items to be tested later has its effect by reducing the amount of rehearsal devoted to remember items in lists where such a cue occurs. The possibility that a more general phenomenon was involved, that is, that items to be tested later were being recycled during noncue lists seems precluded because performance in the condition where the test-later cue was absent was not depressed relative to performance in the forget group.

The final recall test indicated that subjects acted in accordance with our instruction about the meanings of the forget cues. Specifically, performance when subjects knew they were going to be tested later on forget items was significantly superior to performance when such a test was not expected, F (1, 132) = 13.99, $p < .001$. By contrast, the performance of the two groups on the subsequent recognition test was not reliably different, F (1, 132) < 1. These results are consonant with Bjork's (1972) analysis of the influence of differential rehearsal on directed forgetting. Bjork's position is that such rehearsal can be expected to influence retrieval and thus performance on a recall test, which involves retrieval. By contrast, the recognition of forget items depends only upon their initial registration and is independent of the amount of rehearsal devoted to them. Thus, the absence of any substantial difference in recognition between the forget and test-later groups is to have been expected.

Experiments 5 and 6

The main thrust of these experiments concerns the directed forgetting mechanism of differential rehearsal. Secondarily, they have implications for two of the other mechanisms described earlier, namely, differential grouping and erasure. Unlike the previous experiments where the interest was in the retention of remember words, the aim of these experiments was to assess retention of forget material.

Method. The task was single-trial free recall of common unrelated words presented visually at a 1.5-sec rate. A list contained 32 words with 6 lists presented in Experiment 5 and 8 in Experiment 6. There were 88 and 57 subjects in these two experiments, respectively.

A basic independent variable was whether or not a list contained a forget cue. In these experiments a dollar sign after the 12th word was the signal to forget. Thus in a forget-cue list there were 12 forget words and 20 remember words and in a no-forget cue list, 32 remember words. In each experiment, half the lists contained a forget cue.

The other major independent variable was the occurrence or nonoccurrence of repeated words within lists. In Experiment 5, either no words were repeated, the 18th word was a repetition of the 6th, or the 24th word was a repetition of the 12th. In Experiment 6, both the 18th and 24th words of a list had been presented previously in positions 6 and 12, respectively, or they had not. Thus in Experiment 5, a list could contain one repeated word and in Experiment 6, two repeated words. In any event, whether repeated or not repeated, we shall hereafter refer to words occupying the 18th and 24th serial positions as critical items.

The major point of these experiments that must be appreciated is the positioning of the first and second occurrences of repeated words vis-a-vis the presentation of any forget cue. Note first, that the cue separated the occurrences of a repeated item. Second, note that the initial position of an item occurring both before and after a forget cue was either immediately prior to the cue or six inputs prior to it. The rationale behind this variation with respect to the mechanism of differential rehearsal was as follows: According to this mechanism, rehearsal of forget items should terminate upon the presentation of a forget instruction. At this point, it would be expected that most of the rehearsal of an item six positions in advance of the cue would already have been accomplished, whereas the rehearsal accorded to an item presented immediately before the cue would be substantially curtailed. Assuming that the extent of long-term storage is an increasing function of rehearsal, then the long-term strength of the former kind of item should not be appreciably diminished whereas it should be for the latter kind of item. Subsequent repetitions of these two kinds of words were assumed to lead to eventual recall performance which mirrored

the effects on long-term trace strengths due to the occurrence of a forget cue. In particular, on the basis of differential rehearsal, one would expect that the benefits of two presentations of an item separated by a forget signal would be substantially reduced only when the initial presentation of the repeated item immediately precedes the signal.

Results and Discussion. Table 6 presents recall proportions for critical words in the two experiments. The pattern of results is the same in both cases

Table 6

Recall Proportions for Critical Words

		Words presented twice			
		Serial position of the second presentation. Lists with a forget cue are denoted by an F.			
Experiment	Words presented once	18	18F	24	24F
5	.31	.57	.52	.65	.49
6	.23	.50	.49	.54	.33

despite the fact that the critical words appeared to be somewhat easier to recall in Experiment 5. The first thing to note is that recall of repeated words even when separated by a forget cue was always superior to recall of nonrepeated words. Apparently, then, the occurrence of a forget cue does not lead to the complete erasure of information stored in conjunction with forget items. Nevertheless, it does seem to make a difference as to when a forget cue is presented relative to the input of items which are instructed to be forgotten. Whereas recall of repeated items recurring in position 18 was independent of whether or not a forget cue separated the two presentations, F (1, 10) < 1 and F (1, 18) < 1, for Experiments 5

and 6, respectively, there were substantial differences with respect to repeated items recurring in position 24. Specifically, recall of a repeated word originally presented immediately prior to a forget cue was depressed relative to recall in the absence of a cue, F (1, 10) = 4.66, $p < .10$ for Experiment 5 and F (1, 18) = 6.74, $p < .05$ for Experiment 6. The tenor of these results is thus quite consistent with the expectations derived from the mechanism of differential rehearsal which were outlined previously.

Another implication of these data concerns the mechanism of differential grouping. To begin with, it is to be noted that to some extent, differential rehearsal implies cognitive differentiation of forget and remember items. Does such differentiation involve storage in different locations in memory, however, as Bjork (1972) has recently implied? If such is the case, then it would seem to follow that in this experiment, re-presentation of a forget word as a member of the remember set should not make contact with the trace of its original presentation with the effect that repetition benefits should not accrue to a forget word. Since the results of these experiments were quite to the contrary, the conclusion to be drawn is that differential grouping of remember and forget items is not literal, that is, does not involve storage in different memory locations.

Experiments 7 and 8

These experiments bear principally on the processes of differential grouping and differential rehearsal. The differential grouping factor was investigated by either blocking or mixing remember and forget items in the presentation sequence. The thinking was that a mixed order of forget and remember items on a study trial would make set differentiation somewhat more difficult thereby leading to poorer retention of remember items. The factor of differential rehearsal was examined at three levels: conditions were arranged such that all rehearsal was devoted to remember items, more rehearsal was devoted to remember items than forget items, or rehearsal was approximately equally divided between remember and forget items. The anticipation was, of course, that the amount of interference from forget items should vary inversely with the degree of differential rehearsal favoring the remember materials. Retention in these experiments was assessed by a recognition procedure. The main difference between the studies was that in

Experiment 8 a test involving the forget items and some of the remember items was administered after all lists had been presented.

Method. In contrast with the previous experiments, an item-by-item cuing procedure was adopted. In particular, each word was followed by either an "X" or an "O". Half the time the X meant remember the item and the O meant forget it, and half the time, the meanings of these signals were reversed. The study material -- common unrelated words -- and the cues were visually presented at a 2-sec rate, and the subjects said each word aloud as it was presented. Each of six lists consisted of 12 remember words and depending on conditions, either 12 forget words or 12 three-digit numbers. At the end of a list attention to the recognition test was delayed for 30 sec by the administration of a set of number series problems (Experiment 7) or a task of recognizing nonword CVC trigrams as new or old (Experiment 8).

In each experiment, there were six independent groups of 12 subjects. These groups reflected the factorial combination of two variables. The first concerned the integration of forget and remember items in the presentation sequence. For half the subjects, the forget and remember words were blocked in the study sequence; that is, half the time the remember items occurred first and then the forget items and half the time the forget items preceded the remember items. For the other half of the subjects, the remember and forget words were integrated in the presentation sequence. That is, they were presented randomly subject to the restriction that no more than two of either type occur in succession. Hereafter, we shall refer to the former condition as the block condition and the latter, as the mixed condition.

The other main independent variable concerned differential rehearsal and its levels may be most conveniently described according to how much rehearsal was devoted to the forget items, namely, none, a minimum amount, or a maximum amount. In the none condition, the forget items were simply not presented. They were replaced by three-digit numbers which the subject knew in advance he did not have to recall. Each of these numbers was followed by a forget cue. Thus, in the none condition, all the words were remember items and each was succeeded by a remember signal. In the minimum condition, both forget and remember words were presented and cued appropriately. In this

case, the subject was told at the beginning of each list what an X and what an O meant. Since the subjects knew immediately after a word was presented whether or not it could be forgotten, it was felt that only a minimum amount of rehearsal would be devoted to each forget item, namely, that involved in registering the word. The maximum condition differed from the minimum condition in that the subjects were not preinstructed as to the meaning of the Xs and Os. Rather, an instruction immediately after the terminal input indicated which were the remember items. The thinking here was that since the subject did not know until the end of the list which were the remember items he would have to devote rehearsal activity to both sets of words.

In Experiment 7, each recognition test consisted of 12 targets and 12 nontargets. In the conditions where forget words were presented, 6 of the 12 nontargets were forget words and 6 were new words in the sense that they had not been seen previously in the context of the experiment. For groups which saw no forget words, the 12 nontarget items were simply new items. In Experiment 8, each recognition test consisted of 10 target items and 12 nontarget items and the nontarget items were divided in the same way as in Experiment 7. The subject made a confidence judgment to each test item ranging from 6 (positive the word was a member of the remember set) to 1 (positive the word was not a member of the remember set). In Experiment 8 there was also a final recognition test administered approximately 2 minutes after the recognition test on the last list. This final test consisted of the 12 remember or target words not previously tested, the 36 forget words not previously tested, and 12 entirely new words. Confidence judgments as previously described were required for this test.

Results and Discussion. The proportions of hits and false alarms on immediate recognition tests in Experiments 7 and 8 are presented in Table 7. The more potent of the independent variables was the degree of rehearsal accorded to forget words (or alternatively, the degree of differential rehearsal in favor of the remember words). In Experiment 7, the rehearsal variable was statistically reliable in the case of hits, false alarms on forget words, and false alarms on new words, F (2, 66) $\geq$ 9.46, $p < .001$. In Experiment 8, this was true for hits

Table 7

Proportions of Hits and False Alarms on Immediate Recognition Tests

Rehearsal	Experiment	Blocked			Mixed		
		Hits	False Alarms		Hits	False Alarms	
			Forget Words	New Words		Forget Words	New Words
None	7	.80	.03	.03	.81	.03	.03
	8	.89	.03	.04	.87	.05	.06
Minimum	7	.74	.25	.06	.63	.34	.09
	8	.72	.20	.06	.63	.30	.08
Maximum	7	.61	.31	.14	.63	.31	.15
	8	.64	.24	.13	.61	.27	.09

and false alarms on forget words, F (2, 66) $\geq$ 34.20, $p < .001$, but not in the case of false alarms on new words. In general, the less the rehearsal accorded to forget items, the better the performance. The only statistically significant effect of block versus mixed presentation was in Experiment 8 where false alarms on forget words in the mixed condition were greater than under blocked presentation, F (1, 66) = 4.55, $p < .05$.

Looking at the total picture presented by both experiments and all dependent variables, it would appear that recognition performance in the six major conditions can be classified into three categories. The no-rehearsal blocked and mixed conditions are equivalent and best; the minimum rehearsal blocked condition is intermediate; and the minimum rehearsal mixed and maximum rehearsal blocked and mixed conditions are worst but not much different among themselves. What appears to have happened then is that performance deteriorated when forget items were simply presented in block fashion and it deteriorated even more when they were either mixed in the presentation sequence with remember items or were accorded a considerable degree of rehearsal regardless of whether they were blocked or mixed in the presentation sequence.

Final recognition performance in Experiment 8 is presented in Table 8. Once again, the effective variable is the degree of differential rehearsal favoring the

Table 8

Proportions of Hits and False Alarms on Final Recognition Test

Item Order	Rehearsal	Hits	False Alarms	
			Forget Words	New Words
Blocked	None	.67	.12	.11
	Minimum	.51	.31	.11
	Maximum	.39	.44	.15
Mixed	None	.65	.16	.14
	Minimum	.44	.27	.08
	Maximum	.43	.46	.17

remember items. Both for hits and for false alarms on forget words although not on new words, performance declined the more the forget items were rehearsed, F (2, 66) $\geq$ 9.13, $p < .001$. The differences between blocked and mixed presentation orders were not significant. Performance continued to be most adversely affected when forget items were presented without regard to whether they were mixed or blocked in the presentation sequence with some indication that the deterioration was perhaps not so great when they were accorded only minimum rehearsal.

These data point to the significant role that differential rehearsal can play in the process of intentional forgetting. Our attempt to hinder differential grouping by mixing remember and forget items in the presentation sequence was on balance not terribly successful. The possibility exists that this may have been due to the use of a recognition test and accordingly Experiment 9 was carried out in virtually the same way as these experiments except that a free recall procedure was used.

Experiment 9

Method. The procedure, materials, and design of Experiment 9 were the same as in Experiments 7 and 8 save for the fact that a free-recall test was completed at the end of each list. There was also a final recall test which asked subjects to write down as many of the words as they could that they had seen earlier regardless of whether they were remember or forget words. Further, the subjects were asked to circle those words which they thought had been earlier cued to be remembered.

Results and Discussion. Means and standard deviations for performance on the immediate recall test are shown in Table 9. Unlike the two previous experiments, both independent variables proved to be statistically significant sources of variation. Thus, performance declined the more that rehearsal was devoted to forget words, F (2, 66) = 49.02, $p < .001$, and was reduced when remember and forget items were mixed as opposed to blocked in the presentation sequence, F (1, 66) = 5.20, $p < .05$. Despite the absence of a significant interaction of these variables, it is apparent that the brunt of the blocked-mixed effect occurred only when forget items were presented and also that the sheer presentation of forget items was not overly interfering in

Table 9

Performance on Immediate Recall Tests

Rehearsal	Blocked		Mixed	
	Mean	SD	Mean	SD
None	6.9	1.0	7.1	1.5
Minimum	6.6	1.6	5.7	1.4
Maximum	4.2	1.1	2.7	1.0

the absence of their maximum rehearsal or their being intermingled with remember items in the presentation sequence.

The mean numbers of remember and forget words recalled on the final test are set forth in Table 10. The differential rehearsal variable continued to be

Table 10

Mean Word Recall and Proportions of Words Identified as Remember Items (in Parentheses) on Final Recall Test

Rehearsal	Blocked		Mixed	
	Remember Words	Forget Words	Remember Words	Forget Words
None	24.3	___	25.8	___
Minimum	21.8 (.95)	3.3 (.17)	17.3 (.92)	4.0 (.52)
Maximum	13.8 (.76)	8.6 (.30)	11.3 (.62)	6.8 (.28)

effective for both dependent variables, F (2, 66) = 17.54, $p < .001$ for remember words and F (1, 66) = 56.71, $p < .001$ for forget words. By the time of the final recall test, however, the blocked-mixed variation was not statistically significant. A final note concerns the accuracy with which subjects identified the words they recalled as remember or forget items. The proportions of items circled as being remember words are shown in parentheses. With the exception of the fact that forget words are misidentified more under minimum than under maximum rehearsal, these statistics by and large were responsive in the same way as was recall to variations in rehearsal and in the presentation of remember and forget words.

CONCLUSIONS OF EXPERIMENTS ON INTENTIONAL FORGETTING

What do the studies just reported have to say about each of the five intentional forgetting mechanisms described earlier? Concerning erasure, it would appear that if there is such a mechanism, its operation is far from perfect. In all experiments which we have conducted wherein the retention of material which one has been instructed to forget has been assessed, we have been able to find evidence that traces of forget material are still available in storage. Nor do our studies, in our opinion, give much support to the recycling hypothesis. In Experiment 1, a group of subjects recalled a set of words in the face of having to recall a second set when it had finished with the first set. Nevertheless, this group still achieved a higher level of recall than a group simply tested on the first set of words after having been told earlier to forget them. Additionally, Experiment 4, wherein some subjects were cued to be tested later on certain items, indicated that the adverse effects of keeping such items in mind were restricted to the lists in which they were presented and, as one might have expected on a recycling notion, did not extend to other lists which did not contain forget items. Of course, the possibility that subjects in this experiment recycled items to be tested later only during the retention test following the list in which they were presented cannot be ruled out.

As for the three non-mutually exclusive mechanisms -- differential rehearsal, differential grouping, and selective search -- the experiments reported bear mainly on the first two of these mechanisms. Nevertheless, because selective search is undoubtedly facilitated by differential rehearsal and is probably dependent upon differential grouping of remember and forget items, the data of the present studies do suggest some grounds upon which the selective search mechanism may operate. Insofar as set differentiation is concerned, Experiments 1, 2, and 9 indicated that such differentiation is eroded or even eradicated by semantic similarity between sets, by a lack of temporal differentiation of the sets, and by a delay prior to recall of remember items. Furthermore, Experiment 3 suggested that discriminative difficulties between sets are a necessary although not a sufficient condition for interference from forget items effected by manipulations in such variables.

Operation of the mechanism of differential rehearsal in these studies is most strongly implicated by the results of Experiments 5 through 9. By means of an item repetition procedure, Experiments 5 and 6 revealed that the less rehearsal a forget item has been accorded the poorer will be its retention. Experiments 7, 8, and 9 demonstrated that the less rehearsal accorded to forget items, the less will they decimate the retrieval, either recognition or recall, of remember words.

EXPERIMENTS ON NONINTENTIONAL FORGETTING

Several lines of research have been conducted under the aegis of this grant which do not bear directly on the problem of intentional forgetting. Nevertheless, like the research on directed forgetting, they do bear on the general problem of human forgetting. The purpose, general method, and summary outcome of each of these projects will be taken up in turn.

Explorations of the Tip-of-the-Tongue Phenomenon

The concern of this experiment was with that state of mind in which recall of information from long-term memory while unsuccessful is agonizingly imminent. Such experiences have occurred to most of us and usually concern retrieval of such things as words, people's names, and miscellaneous facts of information. This experiment attempted two things; first, to capture the course of the resolution of such tip-of-the-tongue (TOT) states over time and second, to refine the relationship between ultimate recognition and prior feelings of knowing about the contents of memory.

Method. Forty male and female undergraduate students were tested on 24 general information questions. To each one they gave the following: a feeling-of-knowing judgment of the answer ranging from 1 (definitely know) to 4 (definitely don't know); an indication of whether or not the answer was on the tip-of-the-tongue; an answer, even if it was a guess; and a confidence judgment of the answer ranging from 1 (certain correct) to 4 (certain incorrect). Thence ensued an interval of approximately 48 hours during which the subjects are asked not to think of any of the questions. However, if the answers to any missed questions came spontaneously to mind, he was to record them on a prepared response sheet he had been given. The second session consisted of another presentation of the 24 questions with the nature of responding as just described. A third presentation of the questions in the form of a four-alternative forced-choice recognition test followed immediately with a confidence judgment -- 1 (certain correct) to 3 (a guess) -- required for each response.

Results and Discussion. Of the session 1 TOTs meeting the numerous definitional criteria, 36% were resolved by the end of the first questioning, 61% by the end of the 48-hour interval, 69% by the end of the second questioning, and 100% by the end of the recognition test. Cumulative percentages for a comparable

group of non-TOT questions were 2%, 18%, 43%, and 100%, respectively. Such observations give testimony to the strong liability to recall associated with TOT states.

Ultimate recognition was positively related to the strength of feeling-of-knowing judgments tendered during the second testing session. However, the range of the function could be increased over what is generally observed by treating questions evoking TOT states as belonging to a category stronger than the strongest feeling of knowing. Thus, the percentage of correct recognitions for TOT states was 82% and this declined to 46% for the weakest feeling of knowing. By contrast, Hart (1967) found that subsequent correct recognitions for feeling-of-knowing states were 56% and for non-feeling-of-knowing states, 42%. Clearly, the relationship between subsequent recognition and feelings of knowing can be refined by considering as a separate category those feeling-of-knowing states where recall is on the tip of the tongue.

Proactive Inhibition and Practice Effects in Single-Trial Free Recall

This research represents the doctoral dissertation of James Goodwin. He had observed that when subjects are repeatedly presented and tested by the method of free recall on lists of common unrelated words, some reliable changes occur over the course of testing. One is a change in the function relating percent correct and input position. On list 1, performance on first presented items is superior to recall of last presented items. In other words, there is more primacy than recency. As the experimental session wears on, the level of recall of first presented items decreases and that for last presented items increases. That is, there is a shift from primacy to recency. Another observation, and one which is correlated with this shift from primacy to recency, is a change in output statistics with additional lists. Early in an experimental session, recall tends to begin with first presented items. On later lists, however, it is the terminal items which are recalled first.

Goodwin's particular interest was in the decline in the primacy effect (i.e., level of recall of first presented items) with practice. Five studies were conducted and they succeeded in showing rather convincingly that this effect is only minimally if at all due to the correlated change in output strategy which occurs with practice. The general approach which Goodwin

adopted was to show that output statistics could be varied considerably without any corresponding variation in the decline in primacy with practice. Rather than describe each of the five experiments in detail, a general flavor of the investigation will be conveyed by considering only one of the experiments, one which employed, in fact, a variation of a directed forgetting procedure.

Method. Three lists of 15 common unrelated nouns were visually presented at a 2.5-sec rate to two groups. In addition to standard free recall instructions, the subjects were told that they might not be tested after every list, and that if they were not tested, they would spend time equivalent to what they otherwise devote to recalling words to working on number-series problems. At the end of each list, subjects were cued either to recall the words or to work on the number-series problems. In one of the two groups, the recall group, subjects were tested on all three lists. In the other, the number series group, only the last list was tested.

Results and Discussion. If one looks at serial position curves for list 1 and list 3 of the recall group, the usual drop in primacy with practice is clearly evident. More importantly, the primacy portion of the only list on which the number series group was tested was virtually identical to the third list on which the recall group was tested. Apparently then, a decline in primacy can occur even though one has had no prior experience in recalling lists of words. In addition, the output statistics indicated that the number series group showed no disposition toward recalling either primacy or recency items first. This contrasted with the recall group wherein a definite shift in output strategy occurred, that is, from recalling first presented items first on list 1 to retrieving last presented items first on list 3.

Since an output strategy interpretation of the decline in primacy with practice did not seem very compelling, Goodwin concluded by suggesting that the decline is due to a build-up of proactive inhibition as more and more lists are studied and tested. While such an interpretation possesses face validity and also makes contact with explanations advanced for a similar phenomenon in another context (cf. Wickens, 1970), it suffers from being rather general and certainly requires more severe testing than Goodwin's experiments subjected it to.

Temporal Dating and Single-Trial Free Recall

It is clearly the case that memory has a temporal dimension; more often than not we remember which events occurred before, simultaneous with, or after which other events. Whether such information is functional in the retrieval of information from memory, however, is another question. And it was to this question that James Goodwin addressed himself in this research which served as his Master's thesis and which is reported in the American Journal of Psychology, 1972, 85, 597-604.

As in the research just described, the empirical focus was once more on the decline in primacy which occurs with practice in the task of single-trial free recall. Is it possible that this decline is paralleled by a decline in memory for temporal information acquired during the presentation of a list which is to be tested by free recall? If so, then one could continue to entertain the notion that temporal information is important to the retrieval of at least initial list members in free recall. But if not, then one possibility could be that temporal tags are of little functional value in free recall. To assess the retention of temporal information, a reconstruction task in which one reassembles a scrambled order of list members into its proper order was used.

Method. Each list contained 15 unrelated concrete nouns presented visually at the rate of 1 word every 1.5 sec. There were two independent variables of interest whose factorial combination yielded four independent groups with 36 subjects being assigned to each one. Half the subjects received 1 list and half the subjects received 6 lists. The critical lists in these two conditions are the 1st and 6th lists, respectively. These critical lists were tested half the time by free recall and half the time by reconstruction. However, they were studied under the impression that they were to be tested by free recall.

Results and Discussion. The critical observations in this experiment were the primacy effects on the critical lists under the two methods of testing. For free recall, there was the conventional decline in primacy with practice, that is, from list 1 to list 6; but with reconstruction, no such well-defined decline in primacy occurred. This result is certainly susceptible to a number of interpretations. But one of them, and the one preferred by Goodwin, was that the

results are not consistent with the point of view which stresses the efficacy of temporal tags as cues for the retrieval of early list members during free recall.

Retroactive Facilitation in Short-Term Retention of Minimally Learned Paired Associates

Three experiments conducted in collaboration with a faculty colleague, George E. Weaver, and reported in the Journal of Experimental Psychology, 1973, 100, 9-17, were designed to extend to the realm of short-term memory some of the basic transfer paradigms used in the study of long-term memory. The initial concern was to test the generality of the interference theory of forgetting and to determine whether or not short- and long-term memory are mediated by a single type of storage mechanism. As the experiments progressed, however, it became apparent that the results would have little to say about such issues. Nevertheless, they did generate observations which were of interest in their own right.

Method. The procedure, which was common to all three experiments, involved the presentation of short lists of paired associates. Following each one, retention was tested for two or three of the pairs by presenting their left-hand members and asking the subjects to give what they thought were the corresponding right-hand members. The composition of these tested or critical pairs was one major independent variable. We may illustrate by reference to the first of the three experiments. The pairs were entirely dissimilar or they contained identical left-hand members. A second major independent variable concerned the number of occurrences (either 1 or 2) of the second presented critical pair. The other two experiments were mainly variations on the theme of manipulating the nature of the critical pairs. Common to all three experiments was a third independent variable, namely, where the critical pairs occurred in the list. They were presented either at the beginning, in the middle, or at the end of a list. And, of course, the subjects did not know in advance just where they would be placed.

The pairs in each list consisted of either trigrams or words as left-hand members and words as right-hand members. Each subject was tested 2-4 times under all conditions of an experiment. Finally, pair presentation was visual and at the rate of one pair every 2 or 3 sec.

Results and Discussion. The most consistent and outstanding result of these experiments concerned recall of the first presented critical item. When first and second pairs shared identical stimuli, performance on the first pair was facilitated relative to the case where the two pairs did not share identical stimuli. Such a finding contrasts sharply with the data from studies of long-term retention wherein recall of a first learned set of paired-associates is depressed if a list learned second shares the same left-hand members. The explanation that we prefer for our results is simply that pairs with identical stimuli are rehearsed together more than are items from a paradigm comprising different stimuli.

Type of Rehearsal and Delay in Single-Trial Free Recall

Rundus and Atkinson (1970) have described an overt rehearsal procedure which they have used in the context of a free recall task. As used in their experiment, each word in a list was presented visually for a 5-sec interval. During this time, the subject rehearses aloud any items from the list which enter his mind. There are no restrictions on the order of rehearsals and the only requirement is that subject must maintain a constant flow of rehearsal activity for the entire 5-sec interval. Such a procedure has proved useful in generating theoretical notions about human memory in general and the task of free recall in particular. Nevertheless, the possibility exists that this procedure yields a somewhat distorted picture of what subjects are ordinarily doing during list presentation, and it was this possibility which was investigated in the current experiment.

The procedure was simple enough. Two groups of subjects were compared, one of which rehearsed overtly and the other which rehearsed covertly. A within-subjects variable was then manipulated in each of the two groups; specifically, the free recall test following each list was administered either immediately or after a delay of 20 sec. The question was whether or not performance would be comparable in the two groups which rehearsed differently.

Method. Six lists of 15 unrelated nouns were presented at the rate of one word every 5 sec and each was tested by the method of free recall. Half the lists were tested immediately and half were tested after a 20-second delay during which subjects read digit arrays aloud as fast as they could. No more

than two consecutive lists were of the same type. One group of 36 subjects was given standard free recall instructions and hence rehearsed silently or covertly. Another group of 36 subjects rehearsed overtly following the procedure described by Rundus and Atkinson (1970). That is, subjects in this group were free to rehearse list items in any order provided that they filled each item presentation interval with rehearsal activity.

Results and Discussion. Inspection of the functions relating percent correct to input position revealed that the delay in testing resulted in similar reductions in the level of recall of those items presented last for both overtly and covertly rehearsing subjects. Nevertheless, there were differences between the groups. In particular, overt rehearsal led to better recall of initial items whereas differences in favor of covert rehearsal were evident over nearly all of the subsequent serial positions. Taking all input positions together, the group of subjects rehearsing covertly recalled an average of 9 words per list whereas overtly rehearsing subjects recalled an average of only 7.9 words per list. These differences lead one to wonder about the extent to which one may safely draw conclusions about the operation of the human memory system under ordinary circumstances from data collected with the overt rehearsal procedure of Rundus and Atkinson (1970). At the very least, what is indicated is that subjects left to their own devices do not adopt processes for remembering information which correspond to overt rehearsal activity.

Retention of Isolated Words

Why is a word which is made perceptually distinctive in a list remembered better than a comparable word which is not perceptually distinctive? One possibility is that when a particular item in a list is associated with a distinctive stimulus attribute, the attribute serves as a cue which directly facilitates subsequent retrieval of the item. Another possibility is a selective attention-rehearsal hypothesis: an isolated item is more likely to be remembered than a comparable non-isolated one because it tends to be held in mind longer. These two possibilities were examined in this research.

Method. Three experiments were conducted which differed only slightly from one another. In all of them, lists of 20 common words were visually presented at either a 1- or 2-second rate and tested by either free recall or recognition. Each list contained four

critical words. These words were either (1) semantically related (2) semantically unrelated but enclosed in rectangles (isolated items), (3) both semantically related and enclosed in rectangles, or (4) neither semantically related nor enclosed in rectangles (control items). The critical words either occurred consecutively, that is, were massed during presentation, or were distributed throughout the list.

Results and Discussion. The results of all three experiments appeared to support the conclusion that the isolation effect is the result of special attention or rehearsal given to perceptually distinct stimuli, and that it is not the result of the distinctive attribute per se serving as a retrieval cue. The results which supported this conclusion were: (1) that enhanced recall of isolated items was at the expense of other items in the list; (2) that the superiority in the recall of isolated over control items was greatest for the first isolated words in a list; (3) that the isolation effect persisted in recognition where problems of accessibility are presumably eliminated whereas the effect of the semantic cue (i.e., semantic relatedness) was cut sharply; and (4) that the isolation effect was not reduced after distributed presentation whereas the effect of semantic relatedness was.

CONCLUSIONS OF EXPERIMENTS ON NONINTENTIONAL FORGETTING

General conclusions based on all the data reported in this section are virtually impossible in view of the widely varying nature of the researches. However, we see three points of contact among them and it is these which will be emphasized here.

The first of these concerns rehearsal as a control process. Two of our lines of research, namely, that involving the short-term retention of paired associates and the retention os isolated items have appealed to rehearsal in explaining observed phenomena. Furthermore, the experiment in which controlled and uncontrolled rehearsal were compared confidently concluded by saying that covert rehearsal activity is unlike the simple repetition of items. But hidden behind these appeals to rehearsal and assertions about its nature is a basic ignorance of just what rehearsal does. Thus, to attribute some phenomenon to rehearsal only raises the further question of how rehearsal produces that phenomenon. Moreover, to say what rehearsal is not is quite a different matter from saying what it is.

Two of the researches which were described, namely, the Master's thesis and dissertation of James Goodwin, dealt with the decline in primacy which occurs with practice in single-trial free recall. While this is a rather minor empirical phenomenon, it nevertheless appears to implicate and exclude explanatory factors of rather considerable importance. In particular, it appears that temporal information ordinarily stored in the course of remembering is not an important basis for the retrieval of information from memory. And secondly, the importance of previously studied material as a powerful interfering force in the retention of information is once again implicated.

The final point we should like to make concerns the importance of retrieval. The tip-of-the-tongue phenomenon is an excellent example of a retrieval failure; what is sought after is clearly in memory but there is a failure to access fully the requisite information. One wonders whether most of our memory losses are due not so much to the unavailability of information but to its inaccessibility. If this is true, then the real problem becomes one of finding the appropriate retrieval cues. And it may be that this is the essential nature of rehearsal, that is, identifying appropriate retrieval information by which to locate and extract at some later time information from memory.

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